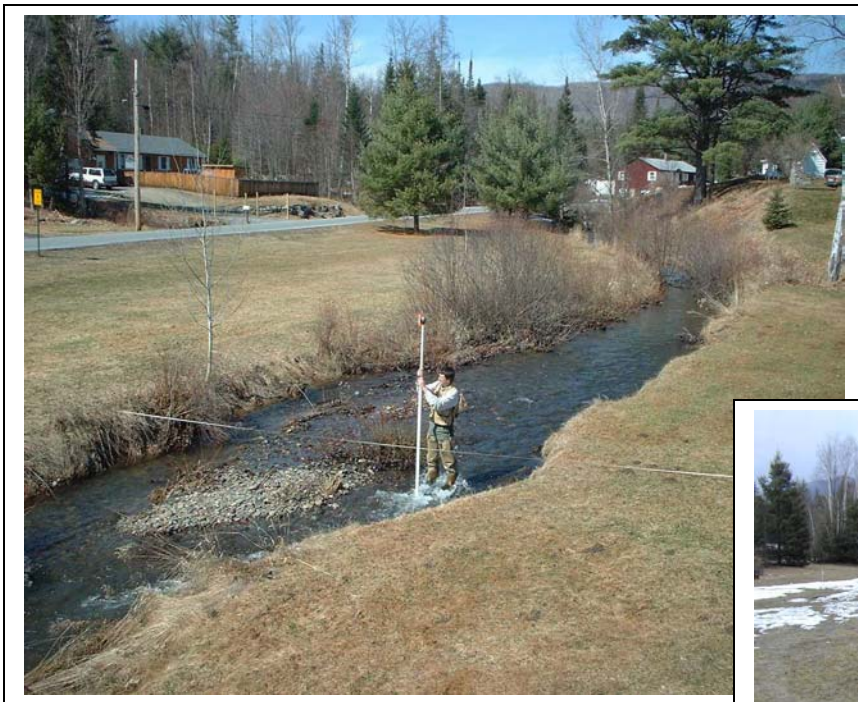

GENERIC QUALITY ASSURANCE PROJECT PLAN FOR STREAM MORPHOLOGY DATA COLLECTION

June 17, 2003

Generic Quality Assurance Project Plan
for
Stream Morphology Data Collection

Fourth Draft
June 17, 2003

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Signature / Date
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A2 – Table of Contents

Cover Photos: - top left - Palmer Brook, Littleton, NH (E4 - stream type above, conversion to C4 stream type at cross-section location
center - Caleb Brook approaching the bankfull stage, Lancaster, NH (E4 - stream type)
bottom - Bog Brook, Stratford Hollow, NH (C3 stream type)

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A3 – Distribution List

This is a generic QA Project Plan (QAPP) for grant projects funded through DES using EPA Clean Water Act section 319 money that involve stream morphology data collection. A Site-Specific Plan (SSP) will be written for project-specific work. Table 1 lists people who will receive copies of the approved QAPP and any subsequent revisions.

Table 1. QAPP Distribution List

QAPP Recipient Name	Project Role	Organization	Telephone number and Email address
Andrea Donlon	Program QA Coordinator	NHDES Watershed Management Bureau	603-271-8862 adonlon@des.state.nh.us
Vincent Perelli	NHDES Quality Assurance Manager	NH DES Planning Unit	603-271-8989 vperelli@des.state.nh.us
Warren Howard	USEPA Project Manager	USEPA New England	617-918-1587 Howard.Warren@epa.gov
Steve DiMattei	USEPA Quality Assurance Officer	USEPA New England	617-918-8369 dimattei.steve@epa.gov

In addition, several people involved in site-specific work will receive the generic QAPP as needed. Those people include:

- Project manager
- Field team leader
- Data Processor
- QA Officer
- Data reviewers
- Essential Contractor or subcontractor personnel (hydrologist, geomorphologist , or engineer)

A4 – Project/Task Organization

The following project organizational chart lists the roles and lines of communication among those individuals or organizations involved in stream morphology projects. Contact information and names of job specific grant recipients, individuals, and organizations will be included in the SSPs. Some organizations as determined by the needs of the project are optional and can be omitted (see dashed boxes in Figure 1).

Figure 1. Project organizational chart

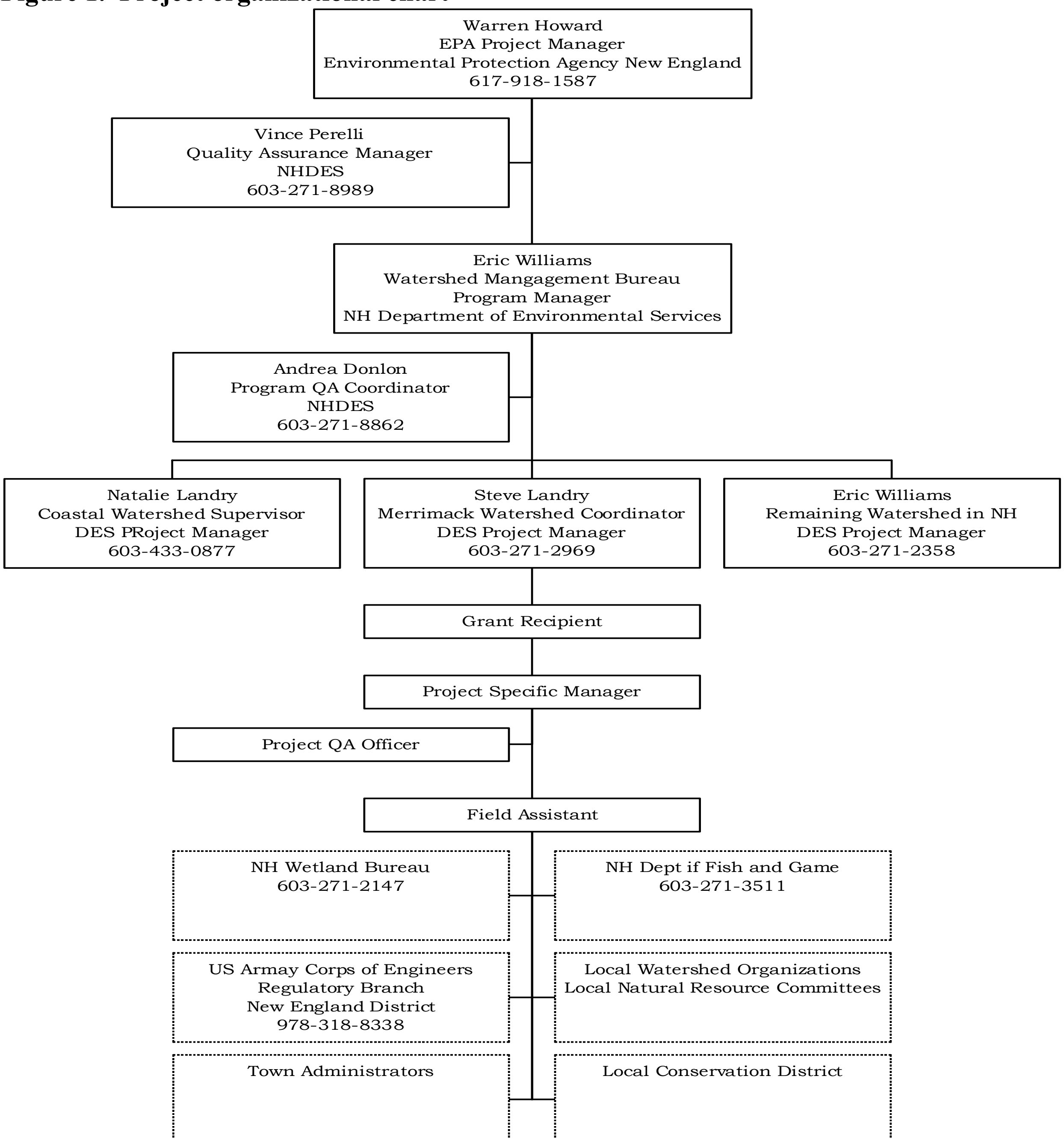

Table 2 identifies the roles and responsibilities of those individuals involved in the project. Project specific roles will be identified in the SSP. Stream morphology data collection will be performed by a reputable qualified hydrologist, engineer, or geomorphologist, with the assistance of a qualified field assistant. The project manager will be responsible for submitting an approved SSP.

Table 2. Personnel Responsibilities and Qualifications

Name and Affiliation	Responsibilities	Qualifications
Qualified Hydrologist, Engineer, Geomorphologist, or similar	Project manager	Trained in stream morphology data collection, analysis, interpretation, and stream survey techniques
Field Assistant	Assist with field data collection	Trained in stream survey methods
Qualified Engineer or technician	QA/QC officer	Trained in stream morphology data analysis and interpretation
Andrea Donlon NH DES Watershed Management Bureau	Reviews QAPP preparation and other QA/QC activities	On file at NHDES
Steve Landry NH DES Watershed Management Bureau	Reviews and oversees projects funded by DES 319 Restoration grants in Merrimack watershed	On file at NHDES
Natalie Landry NH DES Watershed Management Bureau	Reviews and oversees projects funded by DES 319 Restoration grants in coastal watershed	On file at NHDES
Eric Williams NH DES Watershed Management Bureau	Reviews and oversees projects funded by DES 319 Restoration grants in Connecticut, Saco, and Androscoggin watershed	On file at NHDES

Principal data users may include the project manager, local landowners and government agencies, NHDES Watershed Management, and the US EPA. Secondary data users may include the NH Fish and Game Department, NHDES Wetland Bureau, and the US Army Corps of Engineers. Other secondary data users may include the local Conservation District, local watershed associations, and the public. Coordination with state, federal, or local organizations, or the public, for the purposes of initial data collection, eyewitness accounts, etc. may occur.

A5 – Problem Definition/Background

Preserving, improving, and restoring the physical and biological integrity of our nation's waters are goals of the Clean Water Act expressed through the implementation of programs by the New Hampshire Department of Environmental Services. To that end, stream morphology data are used as a decision-making tool in determining what actions are needed to meet those goals.

This QAPP covers the work of a professional who will be hired to take measurements that will be used by the grant recipient to quantify physical channel characteristics, make objective comparisons between two or more distinct channel reaches, identify existing problems, and determine appropriate solutions to these problems. Data may also be used in research projects, such as the development of regional hydraulic geometry curves, or to educate interested persons. Additional potential uses for these data are:

- monitoring trends in physical channel characteristics over time;
- quantifying environmental impact from adjacent land uses, diversions, in-stream structures, or similar activities;
- assessing stream and watershed response to management activities;
- providing stream channel data for water allocation decisions;
- supporting resource inventories (habitat, water quality, vegetation);
- allowing comparisons between different streams or distinct reaches of the same stream;
- contributing to regional, national, and international databases;
- stream restoration design and monitoring;
- predicting channel response to in-stream structures, land-use changes, flow regime changes, or similar;
- design of in-stream structures;
- development of land use regulations;
- regulatory permitting decisions, and
- bridge and culvert design.

Geomorphic stream measurements eliminate guesswork and provide an objective way of assessing stream characteristics and conditions. They reveal problems by providing the data needed for classification, assessment, and restoration. When the source of instability is not fully understood, work performed with the best intentions to repair a problem can instead cause greater instability, and actually create a bigger problem.

Stream morphology data are frequently used to determine appropriate methods of restoring channel stability and aquatic habitat. In some cases, however, the cause of stream instability is not readily apparent. Stream morphology data often will reveal the underlying cause and at the same time provide the information necessary to develop a solution. Understanding the source of instability is critical. When this is not fully understood, work performed with the best intentions can create more instability and a bigger problem than it hoped to repair in the first place.

Streams and adjacent lands provide habitat for aquatic organisms and riparian vegetation. When this habitat is disturbed, the populations which depend upon it are also affected. Channel form is influenced by eight interrelated variables: slope, width, depth, velocity, discharge, boundary roughness, sediment size, and sediment load. A change in any one of these variables, whether naturally occurring or altered by man, leads to adjustments in the other variables and the stream morphology as a whole.

One example of a man-induced change is channel straightening which results in a steeper channel slope. The steeper slope increases velocity and channel shear stress which increases the size of transported sediment. This typically leads to channel bed downcutting (increased depth) and a lowering of the local water table. This can result in a shift from hydrophytic riparian vegetation to more mesic species. Bank erosion and later channel migration often ensue (channel widening, increased sediment load, and decreased boundary roughness). This chain-reaction of adjustments results in degradation of aquatic and riparian habitats and water quality. In this scenario bank erosion would likely be the most obvious sign of instability. Hard bank armoring is often prescribed, but this treats only a symptom of the problem, not the cause, and does little to improve aquatic and riparian habitats. Stream morphology data collected in such a stream reach would identify the root of the problem (slope) and these same data collection techniques could be employed on a stable "reference" stream reach to determine the proper slope, width, depth, etc. Restoring the appropriate morphology will in turn restore the aquatic and riparian habitats and the plant and animal communities which depend on them.

A6 – Project/Task Description

Project tasks with their associated deliverables are presented in the table below. Dates are omitted from this generic QAPP chart and will be included in the SSPs.

Table 3. Project Schedule Timeline

Activity	Dates (MM/DD/YYYY)		Product / Type of Measurement	Due Date
	Anticipated Date(s) of Initiation	Anticipated Date(s) of Completion		
Task 1-Site-Specific Plan (SSP) Preparation		*(Before beginning Task 1)*	QAPP Document	
Task 2 – Collection of Available Data (When SSP is approved)	*(First Task)*		Aerial photos, Stream Gage Data, FEMA, FIS	
Task 3 – Stream Gage Survey (if gage is available)	*(Follows completion of Task 1)*		Estimate bankfull discharge and stage at project reach	
Task 4 – Reference Reach Survey	*(Can be done before Task 4)*		Channel Profile	
Task 5 – Project Reach Survey	*(Can be done before Task 3*)		Field survey, channel classification	
Task 6 – Sediment Transport Evaluation	*(Final Field Task)*		Channel materials and river transport power	

The process of taking channel measurements is systematic. Using consistent techniques will provide sound and factual information which will be easily replicated over a period of years and through changes in personnel.

Task 1 – Preparation of Site Specific Plan

Site-Specific Plans (SSPs) will be prepared by the Project Manager, reviewed and approved by the Project QA Manager prior to field work, and a copy retained in the company project files. A copy of the approved plan will be sent to the DES Program QA Coordinator. The Project Manager is responsible for communicating the SSP and other QA/QC requirements to other field sampling staff that may be working on the project.

The SSPs will reference this generic QAPP. Deviations from and stipulations not addressed in the generic QAPP will be incorporated into the SSPs. Details included in the SSPs will be site information, rationale, project description and schedule, analysis, and reporting. Additional information will be considered and added when applicable. Also, the Project Manager will be responsible to locate or produce procedures for any deviations and stipulations, in particular, sampling and testing required for a project that is not described in the generic QAPP, in which case the Project Manager will review and approve. An example outline of the SSP follows.

Site Information

Site map
Sample location map
Personnel identification and organization

Rationale

Problem Definition
Historic Data
Matrix of Concern

Project Description and Schedule

Study Design (sampling location, Sampling and Analysis Method/SOP requirements
Procedures and Requirements
Data Analysis

Reporting

To whom results and discussion are reported

Task 2 – Collection of Available Data

1. Obtain historical and recent aerial photography.
2. Locate project reach on a current USGS map and determine drainage area.
3. Estimate bankfull discharge, width, mean depth, and cross-sectional area from regional hydraulic geometry curves, if available.
4. Obtain active and inactive stream gage records including instantaneous annual peak discharge for the period of record (minimum 20 yrs.).
   Stream flow measurement data (USGS 9-207 forms) may be used to estimate and verify the bankfull discharge and channel cross-sectional geometry at the gage sites and project reach.

5. Obtain Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS), including hydraulic model input data, if available.
   These input data will include channel bed elevations at several locations (cross sections) within the flood insurance study reach. These elevations may be compared to present day channel elevations to determine if the channel has lowered (degraded) or risen (aggraded).

Task 3 - Bankfull Calibration at Stream Gage

One of the most important components of any stream morphology project is accurately determining the stage associated with the bankfull, or channel forming discharge. The most accurate and objective method of determining the bankfull stage is via calibration at a stream gage with a long period of record (20 years minimum data). Stream survey procedures are described in Appendix A. Procedures for calibrating bankfull discharge at a USGS gaging station are contained in Appendix B.

If there is no gage located upstream, downstream, or within a project reach, as is often the case, bankfull calibration at a long-term gage on a channel of the same stream-type, of similar drainage area (+/- 50 %), and a similar hydrophysiographic region should be performed. Cross-sectional geometry and discharge characteristics at the bankfull stage can then be adjusted for the project reach drainage area (i.e., Bankfull discharge vs. drainage area, bankfull width vs. drainage area, bankfull cross-sectional area vs. drainage area, mean bankfull depth vs. drainage area). These relationships will serve as a guide for determining the bankfull stage at the project site.

If no suitable gage can be found, regional hydraulic geometry curves for NH (currently being developed) or Vermont (available) should be used in conjunction with best professional judgement in determining the bankfull stage.

Task 4 – Reference Reach Survey

A stable section of channel, upstream, downstream or in an adjacent watershed which has similar valley characteristics, and is of the same stream type as the stable stream at the project reach (not necessarily the existing stream type), should be surveyed. This "reference reach" can be used as a guide for determining the appropriate channel dimension, pattern, and profile of the project reach.

Cross sectional features (width, cross-sectional area, mean depth, max depth etc.) will be measured in different channel features (riffles, runs, pools, and glides). Profile characteristics including average water surface slope, riffle slope, pool-to-pool spacing, and pool length will be surveyed along with channel pattern features such as meander length, meander radius and belt width.
Differences in drainage area between the project and reference reaches must be accounted for by developing dimensionless ratios.

Additional information about Reference Reach surveys can be found in Appendix C and Plan View measurements can be found in Appendix E as well as Section B2.

Task 5 – Project Reach Survey

Perform field survey of project reach. This will include several monumented cross-sections, a longitudinal profile of the entire reach, plan view measurements, and a pebble count for stream classification purposes (See Appendix D). Cross section locations may be located on a recent aerial photograph, field sketch, or similar plan view map. If possible, a reference mark shown on a FEMA Flood Insurance Rate Map should be used as a survey benchmark.

These following data will be collected:

1. Cross-section surveys
    - Natural ground, channel bed, and water surface elevations along each cross-section.
2. Profile survey
    - Thalweg, water surface, bankfull, and top of bank along the profile (minimum 20 bankfull widths or 2 meander wavelengths in length). Also note the cross-section locations along the profile.
3. Pebble count
    - Perform Wolman Pebble Count.
4. Plan View measurements
    - Stream length
    - Valley length
    - Meander length (L_M)
    - Meander radius (R_C)
    - Belt Width (W_{BELT})
    - Arc Length (L_{ARC})

See Section B2 for detailed discussions on each data collection.

Task 6 – Sediment Transport Evaluation

Perform riffle pebble count and particle size distribution analysis of sub-pavement or bar sample. These data will be used to determine the size of material available as bedload and the combination of depth and slope required to effectively transport this material

These following data will be collected:

- Riffle pebble count
- Bar/bulk sample

A7 – Quality Objectives and Criteria

The quality of field data is extremely important as subsequent decisions may be based upon it. In this generic QAPP all streams must be wadable for measurement purposes, in other words, shallow enough to walk about the water in a safe manner.

Data quality assessment criteria and objectives for measuring data are described below.

Precision: In the initial data collection phase these data are second hand. The USGS Stream Gage Data and FEMA Flood Insurance Studies are all published government documents, so they have inherent acceptable accuracy and precision standards. Aerial photos should be flown by a reputable agency. USGS and USDA both have nationwide photo coverage flown annually, and photos can be found already orthorectified with known scale. Otherwise scale can be calculated using an average of 5 measurements between easily identifiable points, minus any outliers.

During stream data collection, precision can be ensured by using the same analytical instrument throughout the whole data collection process. Benchmarks will be fully referenced. Checking for errors and inconsistencies will be performed regularly in the field by each field team member, and acceptable note-taking and reporting formats will be adhered to. For quality control purposes, when possible, duplicate measurements can be taken by the field assistant. Precision can also be improved by insuring the instruments are properly calibrated according to manufacturer's specifications, and are handled with care throughout the whole process. One should ensure scales are zeroed and instruments have remained level before each measurement. The project manager is ultimately responsible for error scanning and locating inconsistencies when reviewing the data.

Accuracy/Bias: Determining whether data collected are valid and within acceptable limits can be accomplished by comparing it to known values measured at a comparable USGS stream gage site. The measurements should correspond to those taken from a gage station, with differences in drainage area and stream characteristics accounted for. The following table displays applicable limits, with the understanding that when field measurements are taken, any measurements taken to a higher precision will make river surveys easier to close as well as produce more accurate data.

Table 4. Minimum Standards for Measurement Tolerances

Medium	Analytical Method	Measured to	Acceptable Limits Accuracy to +/-
Aerial Photo	Scale Measurements	0.05 inches	50 Ft
Scaled USGS Topo Map	Determining comparable distances	0.05 inches	$^{1}/_{30}$ inches (@ 1:24,000 scale)
Survey tape	Distance measurement – durable waterproof tape graduated in 0.1 feet	0.1 Ft	0.1 Ft
Survey Rod	Elevation measurement	0.01 Ft	0.01 Ft
Scale	Weight measurement	1 oz	1 oz
Field Survey	Vertical Survey closure	0.01 Ft	$.007\sqrt{(^{\text{Total Dist}}/_{100})}$
Survey Level	Benchmark measurement	0.01 Ft	0.01 Ft
Survey Level	Elevation – channel bed and adjacent land	0.1 Ft	0.1 Ft
Survey Level	Elevation – water surface	0.01 Ft	0.01 Ft
Survey Level	Cross-section elevation Measurement locations	Max. Spacing = $^{\text{Bankfull Channel Width}}/_{20}$	N/A
Survey rod	Plumb	Bubble	Second ring
GPS – Hand Held	Coordinate Referencing	Lat/Long	12 Ft

The quality and accuracy of field survey data shall be ensured in the following ways:

- Calibrate level
- Survey closure in the field – A geometric or mathematically closed survey provides checks on the measured elevations and distances. In a closed polygon differential leveling traverse (mathematically and geometrically closed) the survey path returns to the starting point of known elevation or benchmark (BM). A linked traverse (mathematically closed, geometrically open) should end at a point that has a positional accuracy equal to or greater than that of the beginning benchmark. The difference between the known elevation of the benchmark and the calculated elevation is the error. A closure of 0.02 feet is generally acceptable for river surveys. Open traverses should be avoided, because they offer no means of checking for errors and mistakes.
- Survey tape will be stretched tightly to avoid sagging (if channel is so wide that sagging cannot be avoided, then a tag line will be used)
- Data will be plotted in the field to check for errors

Bias can be minimized by removing any outliers from calculations. Bias can also be improved by accounting for and documenting any atmospheric or stream conditions that might alter the measurements. For example, cold temperatures can shorten the length of a metal tape measure, resulting in a greater measured length than actually exists.

<u>Representativeness</u>: The reference reach is a segment of a stable river or stream that has similar valley type and stream morphology as the project reach. Data collected within the reference reach are used to help assess the study area for purposes of river assessment, restoration, stabilization, or enhancement. It is important to select a reference reach that will reflect and be representative of the project reach. Any data from an active stream gage station should be as close to stream type to the reference and project reaches as possible, although not necessarily within the same watershed or river system, but representative of a similar environment. (See discussion under Section A6, Task 2).

Cross sections will be taken at locations which are no more than 5 bankfull widths apart. There will be a minimum of one cross section for each river characteristic (i.e., riffle, run, pool, glide, step) in the reference reach, and a minimum of one for each feature that is present and identifiable in the project reach. Pebble count representativeness depends largely on randomized sampling. Vertical measurements will not be taken on isolated boulders (lag deposits) on the river bed, so as to not skew the results.

The procedures presented in this QAPP are well established procedures; the measurements taken of the study and reference reaches will adequately represent the morphology of the river banks.

<u>Comparability</u>: The QAPP will help standardize the protocol for data measurement and collection, and will help ensure the data collection is repeatable and comparable over time, personnel changes, or against data from similar projects. These data must be collected with the same tolerances and methods for each survey and sampling within the project. When collection techniques remain consistent, these data become more valuable for use in comparison to future and past measurements.

Completeness: There are no legal or compliance uses anticipated for data collected. Results from bankfull calibration and reference reach surveys will be provided to the NHDES Watershed Management Bureau for possible inclusion in Regional Hydraulic Geometry and reference reach databases. Since the channels to be measured are all accessible and wadable, available data will be collected and used from each site unless unanticipated weather or environmental conditions prevent collection. The project manager will determine whether the survey data and samples collected are sufficient to accurately characterize the project and reference reaches.

Quantitation Limits: There are no action limits or detection limits associated with this project, therefore there are no quantitation limits.

A8 – Special Training/Certification

Data collection is conducted and/or overseen by a qualified hydrologist, engineer, geo-morphologist, or similar individual. The project manager will be trained in stream morphology data collection, analysis, interpretation, and stream survey techniques.

The project manager is also responsible for assuring the field assistants are trained to perform fieldwork. The project manager will conduct the training, and/or supplement and fine-tune any prior training the field assistant has had. This training incorporates operation and appropriate use of field instruments and equipment, procedures for taking accurate, comprehensive and readable field survey notes, analyzing field data, and understanding the appropriate need for accuracy and quality control in data collection. Field assistants are required to be familiar with the QAPP and SSP. Field assistants must demonstrate proficiency in calibrating and operating the field equipment and instruments. The training also includes basic fluvial geomorphology theory and river classification.

The use of Table 5 is optional. If applicable, it serves to document specialized training, recurrent training, or certification that has been completed by personnel. It can also list typical tasks on which personnel would need to be trained.

Table 5. Special Personnel Training

Project function	Description of Training	Training Provided by	Training Provided to	Date Completed

A9 – Documentation and Records

All documents will be stored electronically on the project manager's computer system, in project specific folders. Files are to be backed up daily. Project files are archived and kept indefinitely. Hard copies of field data, field notes, second hand data, or print outs of on-going work will stored in a file located on the premises. A copy of the approved QAPP and all associated SSPs will be electronically stored in NHDES's database and a hard copy will be retained in the project file. Major changes to the QAPP will be submitted to EPA and NHDES for approval.

All field notes will be maintained by the project manager and field assistants. Copies will be kept with the file folder. Team members will retain the original copies. Field notes must be completed on-site at the time the data collection occurs. Standard symbols and labels for recording stream surveys are used as per Appendix A – Ch.5, Pg. 14. The minimum required information to be included is as follows:

- Project Name
- Company
- Project Manager
- Survey Team members
- Date
- Detailed location of measurement
- Type of data collection (profile, cross-section, pebble count etc.)
- Time of Day
- Weather conditions
- Any necessary notes or supplemental forms used
- Equipment used – to include manufacturer type and serial number
- Legend

Photo documentation will clearly display the entire bankfull channel of the cross-section being surveyed, to include:

- Both banks;
- The tape in place across stream;
- A chalkboard with following information: location, date, vantage point; and
- Project benchmark used (displayed in another photo).

Notes will state the type of camera and film used, fixed focus (normally 50 mm), focal length of lens (preferably between 28-35 mm, focal length less than 28 mm will cause distortion)

Changes will not be erased, but crossed out and the updated information will be written next to the original value.

B1 – Sampling Process Design

The phase of project process design needs careful consideration and planning. Thorough planning provides a greater chance for success. Before going out in the field and conducting river surveys, it is imperative to do ample research on the area in question. In most cases, benchmarks, gages or reference sites are already in existence. Preferably, these sites will be located in the project watershed. Otherwise, a nearby watershed with similar valley characteristics and stream morphology will serve to represent the study area. Several questions need to be answered, and the answers will make selection of a suitable reference reach and subsequent survey sites easier.

- Do we have permission from landowners?
- What do we want to know about this stream or drainage?
- What variations (geology, elevation, land use) exist in the area?
- How can we set up the most useful comparisons with the fewest sites?
- How can this site contribute to existing or planned efforts?
- How much can be accomplished with existing resources?

A day spent researching files, and contacting individuals that have an interest in the channel (such as local angling and fishery agencies, river advisory committees, white water boating enthusiasts, abutting landowners, local irrigation district, USGS, USDA etc.) can provide valuable information and existing studies can often be expanded for project specific purposes.

Planning helps to avoid conflicts with other scheduled maintenance work. Planning to study the reference reach in July only to discover that the water flow will be diverted for a few weeks while a culvert reconstruction is underway, would be a potentially costly mistake. Field work needs to be coordinated with other scheduled projects, if there is any chance of interference. Mistakes such as these could throw off the project timeline and potentially cause a missed deadline. Studying regional climate, geology, land type, vegetation, historic land uses, and forest plan guidelines can provide a valuable overview of a watershed's character. Planning must be done well in advance of the actual surveying. Access to the sites should be considered, if access needs to be requested. Work should be done during low flow periods; times of peak runoff should be avoided.

<u>Reference Reach</u> - Once the inventory has been completed on the project reach and surrounding watershed, planning the reference reach and survey sites can begin. A nearby stable segment of a river or stream with similar valley type, slope and channel material, will be selected spanning at least one complete meander wavelength of no less than 20 channel widths distance along which the profile will be surveyed. Cross-sections representing one of each feature (riffle, run, pool, glide, step) should be identified and marked for survey.

<u>Project Reach</u> - Within the project reach, at least one cross-section for each feature present and identifiable, should be marked for survey. Criteria for site selection can be found in Appendix A – pp. 6-7. Once ready to begin field surveys, a benchmark or initial reference point should be identified. Occasionally a previously established benchmark can be found near the project site (the U.S. Geological Survey uses brass monuments set in a rock, a concrete pylon, or a pipe

driven deeply into the ground). If one is available, use it. Usually, though, a new benchmark will need to be established at an arbitrary elevation.

Both the Reference Reach and Project Reach surveys will involve measurements of the following four areas:

- Dimension – Cross-Sections;
- Pattern – Plan View;
- Profile – Longitudinal profile; and
- Channel materials – Pebble Count and Bar/Bulk sample.

Discussion on data collection methods follow.

B2 – Sampling Methods

Consistency in data collection is vital. Measurement techniques in this QAPP apply to wadable streams. Basic procedures conducted for stream data collection are intended to be consistent from year to year, to yield a precise, accurate, and comparable assessment of the project reach.

Task 1 – Collection of Available Data

1. Obtain historical and recent aerial photography - photographs can be obtained from a variety of sources. The National Aerial Photography Program (NAPP) in coordination with the USGS and the Aerial Photography Field Office (APFO) associated with the USDA both have national coverage. NAPP produces full national coverage every 5-7 years. Each photo is centered on a quarter section of a standard USGS topo map, and is orthorectified. The photos come in black and white or color IR, which aids in identifying vegetation differences. They are also available in digital format (DOQ – Digital OrthoQuad) at 1:24,000 scale and follow the National Map Accuracy Standards for distance and direction measurements. Historical photos are dated back to 1940.

   APFO has monochromatic photography rectified to scale, which results in a photographic map, accurately representing ground features. Annual photos are taken during the summer months, these photographs are at a 1:7,920 (1" = 660') scale but not geo-referenced. Photographs are available in scales ranging from 1:6,000 to 1:80,000 and are dated back to 1935.

   Photographs can be obtained from the following places:
   - Directly through the USGS at the following web site: http://mapping.usgs.gov/digitalbackyard/aerial.html
   - Directly from the USDA through their web site www.apfo.usda.gov.
   - NH DOQ's can be obtained from regional planning commissions.
   - Aerial photos can also be found at local cooperative extension and USDA offices. These photos are often not rectified so scale must be calculated before any measurements can be taken.

To measure scale of a photograph, one must use either a USGS Topo map, or a map of known scale. S = photo scale = photo distance (*d*) / ground distance (D).

Given a map of known scale, you can calculate the ground distance between two points.
D = photo distance (*d*) * photo scale (S).
The points must be mutually identifiable on both the photo and the map, such as road intersections, bridges, or other permanent features. Take the average of 3-5 measurements, removing any outliers.

2. Obtain regional hydraulic geometry curves, if available, through the USDA – NRCS http://wmc.ar.nrcs.usda.gov/proj.dir/geomorph (Presently available for Vermont, New Hampshire curves should be available in 2004)

3. Obtain active and inactive stream flow measurement data (USGS 9-207 forms – "summary of discharge measurements") through NSIP – National Stream flow Information Program at http://water.usgs.gov/nsip. The USGS also publishes annual Streamgage Data and Flood reports, listing daily stream flow values at each gage. This is well archived, well documented, and unbiased water data.

4. Obtain FEMA Flood Insurance Studies at http://www.fema.gov/fima or call the FEMA Map Assistance Center, Tel. 877-336-2627 to request annual reports on flood profiles, flood elevations, flood histories, and flood risk zones. You can download a FIRM (Flood Insurance Rate Map), an FBM (Flood Boundary Map), and FIS (Flood Insurance Studies) from the web. Hydraulic model input data are generally available in hard copy directly from FEMA.

5. Create general location map of the study area on a USGS topo map and a field sketch map as per Appendix A – Ch.3, Pgs. 8-12.

Task 2 – Stream Gage Survey

As the river survey begins, refer to Appendix A – Ch. 5, for a quick refresher on surveying basics. When taking field notes, use standardized symbols and labels for recording measurements. **Cross-sections are surveyed left to right looking downstream**.

While identifying features that indicate bankfull stage, areas of rip rap, bedrock, bridge abutments, or other physical constraints are to be avoided. Areas heavily eroded or scoured along the outside of meander bends should not weigh as heavily as good indicators such as developed flood plains and point bars on the inside of meanders.

For a step by step procedure for calibrating bankfull discharge see Appendix B. For a more in depth discussion of bankfull and floodplain indicators see Appendix A – Ch. 7, Pgs. 33-36.

Task 3 – Reference Reach Survey

Reference reach surveys are used to develop natural channel design criteria based upon measured morphological relations associated with the bankfull stage for a specific stable stream type (Rosgen, 1996). It is important to do ample research and choose the reference reach carefully, since the purpose of the computations derived from survey measurements is to extrapolate data to disturbed river segments.

Aerial photos can aid in identifying stable segments along the channel by depicting time-trends in river morphology pre- and post-flooding.

A detailed discussion on the protocol for reference reach surveys is found in Appendix C.

- To complete cross-sectional surveys, the channel must be waded repeatedly. For safety purposes the work must be performed during low flow.

    Natural ground, channel bed, and water surface elevations should be collected along each cross-section feature to include a riffle, run, pool, and glide. (See Appendix A - Ch.6 for survey methods.)

  Photo documentation must be included for each cross-section. A benchmark needs to be set up, as per Appendix A – Ch 5, Pg. 15.

  Distances are measured to 0.1 ft. Elevation measurement locations should be spaced a minimum of 1/20th of the bankfull width apart with closer spacing along the banks, at possible bankfull indicators, at major breaks in slope, or other areas where needed. Often elevations of the channel bed and adjacent land are measured to tenths (0.1) of a foot for cross-section and profile surveys, especially when moving the rod a few inches horizontally affects the elevation reading dramatically. However, taken to hundredths will increase the accuracy to a desired standard. Precision is always taken to hundredths (0.01) of a foot for benchmark, turning points, height of instrument, water surface, and bankfull indicator measurements.

  Cross sectional surveys at riffles should extend beyond the bankfull channel to include the flood prone area, in order to measure its width and calculate the entrenchment ratio. Further discussion and protocols for cross-sectional river surveys can be found in Appendix A – Ch. 6.

- Longitudinal Profile Measurement procedures are discussed in Appendix A – Ch. 8. The following should be collected:

    Thalweg, water surface, bankfull, and top of bank along the profile (minimum 20 bankfull widths or 2 meander wavelengths in length). Also note the cross-section locations along the profile. (See Section B2 and Appendix A – Ch.8 for methods).

  Whether the longitudinal survey is done before or after the cross-sectional surveys is a decision made based on experience and what works best for the particular channel characteristics. In some instances, having the elevations of the water surface, riverbed, floodplain, bankfull stage, and terraces may help in deciding where to locate cross-sections.

  Further discussion on longitudinal profiles is presented in Appendix F. Also included in Appendix F is an example of a profile with measured features identified.

- Channel bed composition is needed to classify and characterize the stream. A discussion on bed and bank material characterization can be found in Appendix A – Ch.11.
  The pebble count is done following the survey. At that time the channel features (i.e., riffles, runs, pools, glides, steps) will have been quantified. During the pebble count no less than 100 samples are needed to obtain a valid count. The amount of sampling within each of the features is relative to the percentage of the whole study reach that the feature comprises. For example, if it is determined that the study reach is made up of 30 % pools, 40 % riffles, 10 % runs, and 20 % glides, then 30 samples in three separate transects in pools, 40 samples through 4 transects across riffles, 10 samples across one transect across a run, and 20 samples from 2 transects across glides should be taken. The sampling is along the whole bankfull width, regardless of water surface elevation, so that all area between the bankfull elevations is representatively sampled.
  The procedure to be followed is the Wolman Pebble Count (1954) which is discussed in Appendix A – Ch.11. Pebble count data forms can be found in Appendix D.

- Plan View measurements of the Reference Reach should include:
  - Stream length
  - Valley length
  - Meander length (L_M)
  - Meander radius (R_C)
  - Belt Width (W_{BELT})
  - Arc Length (L_{ARC})

  Guidelines for making plan view measurements can be found in Appendix E. If dense vegetation or river size precludes field measurement, these can be made using recent aerial photographs which have a calculated scale as long as no major changes in channel alignment have occurred between the photo date and the date field work is performed.

<u>Task 4 – Project Reach Survey</u>

The procedures to conduct the project reach survey will be the same as those used for the reference reach. Depending on channel condition, distinguishable channel features may not be present, but those that can be identified should be used. If possible, a reference mark shown on a FEMA Flood Insurance Rate Map should be used as a survey benchmark.

- Discussion and protocols for cross-sectional river surveys can be found in Appendix A – Ch. 6.
- Longitudinal Profile Measurement procedures are discussed in Appendix A – Ch. 8 and Appendix F. Included in Appendix F is an example of a profile with measured features identified.
- Bed and bank material characterization can be found in Appendix A – Ch. 11. The Wolman Pebble Count (1954) procedure should be used (see Appendix D).
- Guidelines for making plan view measurements can be found in Appendix E. If dense vegetation or river size precludes field measurement, these can be made using recent aerial photographs which have a calculated scale as long as no major changes in channel alignment have occurred between the photo date and the date field work is performed.

<u>Task 5 – Sediment Transport Evaluation</u>

- The riffle pebble count is performed using the sampling methods described for the Wolman Pebble Count procedure with the exception that samples are collected only from the bed of riffles (no bank material samples are taken). A minimum of 100 samples are required.

Protocol for Bar/Bulk Sampling can be found in Appendix F along with a corresponding form for recording data. The <u>minimum</u> depth of material to be excavated should be 4-6 inches when the largest particles are measured to be < 2 inches at their intermediate axis. Otherwise the depth to be excavated should be twice the diameter of the intermediate axis of the largest surface particle. Wet-sieve the excavated materials in stages. Occasionally weigh, record, and then dispose of the materials in the sieves, saving the fine-grained sediment remaining in the bottom of the bucket. Fine-grained material (< 2 mm) remaining in the bucket is weighed after all coarse-grained material in the sample has been sieved and weighed.

B3 – Sample Handling and Custody

All samples collected during the pebble count and bar/bulk sampling will be measured and weighed, tallied and classified in the field at the time of collection. The date and time of collection will be recorded in the field book. It is helpful to have a field assistant for these procedures. One field team member will pick samples, measure them, and call out the measurements, while the other tallies the samples, writes down the measurements according to size and repeats them back for confirmation. It is the responsibility of each team member to make sure the measurements have been properly communicated. Once the sample data have been confirmed and tallied, the sample can be disposed of behind the direction of traverse.

For bar and bulk sampling, once the location of the sampling has been determined and the bottomless bucket has been put in place, material to a depth of twice the diameter of the largest surface particle, or 4-6 inches if the largest particles are less than 2 inches at their intermediate axis, is excavated and placed into a container for transport to a level area. Here the sieve set is assembled and wet-sieving the collected sample will be conducted. This process is performed in stages. As the sieves fill up, they are taken apart and weighed individually. After the measurements have been confirmed, the materials are disposed of and returned to the stream bed. If there is any question to the validity of this data, the sampling will be repeated.

B4 – Analytical Methods

Analysis protocols and explanations are detailed in each corresponding Task Appendix as described in Section B2 – Sampling Methods. Bankfull calibration forms are contained in Appendix B. Semi-logarithmic graph paper for plotting particle size distribution of pebble count, riffle pebble count, and bar/bulk samples is included in Appendix D. A Plan view schematic drawing showing plan view measurements and calculations is contained in

Appendix E. Cross Section and Longitudinal Profile plots and calculations are included in Appendix F. Cross-Sections and profiles can be plotted on standard graph paper or using one of several computer programs. They should be plotted to scale. Appendix H contains Reference Reach Stream Channel Classification, Reference Reach Summary Data, and reference reach field forms that can be used during the analysis phase. There is no specialized equipment needed for analysis.

The following analyses are performed after all the data have been collected and plotted. The resulting values are used to determine stream type, assess channel stability, develop restoration plans, and predict channel response to physical alteration or land use change. Comparisons of values obtained in reference and project reaches will oftentimes reveal causes of instability in the project reach and the appropriate dimension, pattern, and profile needed to restore channel stability. Detailed discussions on stream assessment and restoration design are beyond the scope of this document, however, they are founded on the data collection techniques and analysis discussed herein.

CHANNEL DIMENSION - Cross-Sections

- Bankfull Width (W_{bkf})
- Bankfull XS Area (A_{bkf})
- Mean Bankfull Depth ($D_{bkf} = A_{bkf} / W_{bkf}$)
- Maximum Bankfull Depth (D_{maxbkf})
- Width of Flood Prone Area (W_{fpa} = Width at 2(D_{maxbkf}) measured from the thalweg)
- **Width-to-Depth Ratio*** ($W/D = W_{bkf} / D_{bkf}$)
- Entrenchment Ratio* ($= W_{fpa} / W_{bkf}$)

CHANNEL PATTERN - Plan View

- **Sinuosity*** (K = stream length / valley length or valley slope / stream slope)
- Meander Length (L_m)
- Meander Radius (R_c)
- Belt Width (W_{belt})
- Meander-Width Ration ($MWR = W_{belt} / W_{bkf}$)

CHANNEL PROFILE – Longitudinal Profile

- **Average Channel Slope*** (S = elevation drop / stream length)
- Elevation drop is typically measured as the change in water surface elevation between the upstream and downstream end of the profile over a minimum distance of 20 bankfull widths
- Valley Slope (elevation drop / valley length)
- Slope and length of channel features (i.e. riffle length, riffle slope, pool length, pool slope, etc)
- Pool-to-Pool Spacing

CHANNEL MATERIALS

- Particle size distribution from pebble count
  - **D_{50}*** = median size of channel bed material
  - Minimum 100 samples taken from bank to bank
  - Measure intermediate or "B" axis of stone (i.e. not the longest or shortest dimension)
  - Distribute sampling locations based on percentage of different stream features (i.e. if the survey reach if consists of 70% riffles and 30% pools, take 70 samples from riffles and 30 samples from pools)

*** denotes variable required for stream classification**

- Entrainment Calculations
  - Used to determine the combination of depth and slope required to transport bedload
  - Dimensionless Critical Shear Stress:

$$\tau_{ci} = 0.0834\ (d_i / d_{50})^{-0.872}$$

where: di = D_{50} from pebble count performed in bed of riffle only
d_{50} = D_{50} from bar or sub-pavement sample measured via sieve analysis

  - τ_{ci} is used to determine the mean bankfull depth (D_{bkf}) required to entrain the largest particle in the bar or sub-pavement sample from the following equation:

$$D_{bkf} = (\tau_{ci} * 1.65 * D_i) / S$$

Where: D_i = largest particle in bar or sub-pavement sample;
S = bankfull water surface slope in riffle.

- a value of D_{bkf} equal to that measured in the cross-section is an indication that the channel is stable;
- a value of D_{bkf} greater than that measured in the cross-section is an indication that the channel is aggrading;
- a value of D_{bkf} less than that measured in the cross-section is an indication that the channel is degrading.

B5 – Quality Control

In stream morphology data collection there are no contamination issues. There are no time limits to handling, storing, and transporting samples. Systematic introduction of bias is minimal. The opportunity to introduce error, however, does exist during each measurement activity. Quality control is not quantifiable in most cases, and it becomes a subjective assessment of whether data collected appears reliable and qualifies as a valid representation of what is being measured. There are a few steps that need to be taken to minimize imprecision and to identify any errors that might be present. The degree of accuracy that is necessary depends on the intended use of the data.

In the initial collection of available data and research phase, it is important to be as thorough as possible and to get historical data and photography. When calculating scale on photographs, the more measurements used to calculate average scale, the more precise plan view calculations will be. Plan view measurements taken from a series of successive aerial photos spread over several years or decades of the stream reach under study can be very valuable in quantifying changes in channel pattern and the land uses or channel alterations which may have caused them. When cross-referenced with historic discharge data, major changes in channel pattern can be linked to specific flood events. Quality control for collection of second hand data is discussed in Section B9 – Data Acquisition Requirements.

Data collected during Task 2 (stream gage and bankfull calibration survey) are invaluable for accurately characterizing the stream reach and reference reach being studied. Slope, channel materials, width-to-depth ratio, entrenchment ratio, and sinuosity of the study reach are needed to determine the existing stream type. But if the stream is unstable, these values generally do not provide enough information to determine the appropriate channel characteristics associated with a stable channel in the particular geomorphic setting. The reference reach should, as accurately as possible, represent a stable section of the potential stream type. If the condition of the stream channel under study is unstable, the selection of a suitable and representative reference reach can be challenging and one may need to survey a stream reach in an adjacent or nearby watershed. The valley types and slopes of the two reaches should be similar**. A maximum variation of +/- 30% is recommended (i.e., 1.3 > (study reach slope / reference reach slope) > 0.7*).*** In addition the channel materials in the two reaches should be similar (i.e., if the study reach is a gravel bed stream the reference reach must also be a gravel bed stream). These guidelines are intended to ensure that the reference reach stream type is the same as the stable or potential stream type in the study reach.

Once the most important task of locating a reference reach has been accomplished, the field survey can begin. All surveys begin and end at benchmarks of known elevation. All surveys will be closed in the field, and no survey will be complete until it has been closed within the acceptable levels of error of 0.02 ft. If a survey does not close within this tolerance, then it is conducted again. Before a survey is begun, confirm that the tripod base is level and the bubble is centered. This should be rechecked periodically. Make sure the rod is plumb when making measurements. The rod should be moved through the axes, until a minimum reading is determined. Ensure that the elevations are read to the central cross hair. Misreading elevation is a common cause for error.

When performing pebble counts, the 100 random samples that are collected typically give an accurate representation of channel bed materials. Samples are distributed over several transects through several channel features. If the channel is very wide, if the size distribution varies excessively throughout transects of similar channel features, or if the team members feel that the samples collected are insufficient to make an accurate assessment, then more samples will be collected. For quality control, the sampling process roles can be alternated. Errors in data collection will be revealed as outliers or a shift in the particle size distribution curve when plotted. Significant shifts or jumps in the particle size can occur naturally and are termed a bi-modal distribution. This is typically an indicator of insufficient sediment transport competence and channel instability, not data error. In these cases field evidence will be readily apparent, typically in the form of abundant sand embedded within larger gravel and/or cobble.

After the field work has been completed, data points should be plotted in the field. Inconsistencies and outliers should be addressed. All team members should review the analysis calculations for errors. Any discrepancies need to be researched and if the error is not determined, the necessary data need to be measured again.

If error comes from improper collection procedures by the junior field assistant, then retraining needs to occur. The field assistant must show proficiency in data collection procedures before he or she may continue.

B6 – Instrument/Equipment Testing, Inspection, Maintenance

Records will be maintained for all instruments used to ensure conformance to specified requirements. The instrument is evaluated before use to confirm it can be calibrated to the degree of accuracy necessary to accomplish the task for which it has been assigned.

The following instruments are calibrated by the team members or qualified technicians to allow for the maintenance of accuracy in the required measurement capability. Compliance with calibration schedules will be confirmed before each job is begun. The instruments are calibrated using methods and frequency per manual specifications, or when dropped, mishandled, kicked, submerged or similar. A discussion on the care of survey instruments can be found in Appendix A – Pg. 19.

- Surveyor's Level and tripod (with or without stadia)
  A survey instrument should be checked for accuracy the first time it is used. This can be done by performing the 2-peg test, which is explained in Appendix A – Pg.20. If the elevation differences are greater than specified in the test, the instrument needs to be adjusted by a qualified technician.
- Laser Level
  A laser level should be checked before field work is begun, the first time it is used, when damage is suspected, or when custody of the instrument changes. Most laser levels can be easily calibrated per instructions contained in the user's manual. If accurate calibration cannot be achieved, the instrument must be serviced by a qualified technician.
- Transit (qualified technician)
- Total Station (qualified technician)

The following instruments need to be checked for integrity and accuracy, but calibration can be performed in-house.

- Leveling rod (English or metric standard)
  The rod should be checked for bowing, damage to ends, restrictions to full extension, and numbering visibility. It should be calibrated to an object of known length.
- Survey tapes (to match rod, minimum gradations to 0.1 ft. or 0.01 m)
  A fiberglass tape is preferred. It should be checked for missing sections/ends, kinks, and any damage to the coating which would compromise accurate measurements. At this time it would need to be replaced. Nylon coated steel cam-lines are frequently used to perform cross-sections of large rivers as they are much more wind resistant than fiberglass tapes.
- Household kitchen scale
  Scale will be calibrated with known weight annually, or if damage or mishandling is suspected. Scale will be zeroed, or checked for zero before each measurement is taken.
- Sieve-set (2, 4, 8, 16, 32, 64, 128, and 256 mm size)
  Sieve set will be inspected for excessive wear or broken or misshaped mesh before each use.

- Hand-held GPS
  GPS unit must be turned on for a minimum of 15 minutes before collection begins, to ensure the current satellite almanac has been transmitted and received by the unit. The GPS unit will be benchmarked with a position of known geographic location at the beginning and at the end of collection period, and average precision/error can be calculated for points collected. If the error is > 49 feet, then satellite coverage was insufficient at that time.

Following is a continued list of equipment necessary to perform river field work. All should be checked to be in good condition and ensured to be in proper working order.

- Field Book (waterproof cover)
- Ruler (mm)
- Camera (35 mm with 50 mm lens)
- Chalkboard (for photo documentation)
- Small sledge hammer
- 5/8" diameter steel rebar in 24" minimum lengths for cross sectional endpoints, pins, etc.
- Aluminum nursery tags or plastic rebar caps
- Calculator
- Batteries
- Compass
- Field instructions
- Maps (USGS and Road)
- Flagging
- Stakes and clamps for fastening ends of tape
- Paint (hi visibility orange)
- Bottomless 5-gallon bucket, intact 5-gallon bucket, and 5-gallon bucket with weephole and cover with hole slightly smaller than exterior sieve diameter.
- Safety rope (100')
- First Aid kit
- Two-way radios
- Brush cutter
- Hip or chest waders w/wading belt

The following table can be used to document compliance with maintenance of accuracy for instruments and equipment being used.

Table 6. Instrument Equipment Maintenance, Testing, and Inspection

Equipment name	Activity	Frequency of activity	Acceptance criteria	Corrective action	Person responsible
	Maintenance (cleaning)				
	Testing (operation)				
	Inspection				

B7 – Instrument/Equipment Calibration and Frequency

See Section B6 - Instrument/Equipment Testing, Inspection, Maintenance for discussion. The following table can be used to document compliance with time-required calibration for instruments used.

Table 7. Instrument/Equipment Calibration Table

Equipment name	Procedure	Frequency of calibration	Acceptance criteria	Corrective action	Person responsible

B8 – Inspection/Acceptance Requirements for Supplies and Consumables

Not applicable.

B9 – Non-direct Measurements

Historical and recent aerial photography are used for plan view measurements and to determine changes in channel pattern and alignment over time. There is no minimum or maximum scale requirement. The channel needs to be identifiable and clear to get accurate measurements. If possible obtain photographs that are at a small enough scale to identify channel banks. One photograph which contains at least two meander lengths would be optimal for plan view measurements. Photographs need to be vertical to minimize any distortion from oblique angles.

FIRM (Flood Insurance Rate Map), FIS (Flood Insurance Studies), and/or FBFM (Flood Boundary and Floodway Map) which show areas of inundation with base flood elevations (BFE) can be used in conjunction with hydraulic model input data to determine whether aggradation or degradation has taken place at a particular location (cross-section) since the flood study was performed.

Active and inactive stream gage data needs to meet the following criteria to be acceptable:

- Minimum 20 years instantaneous annual peak flow data. The data do not need to be consecutive.
- Maximum 30% of drainage area is regulated or affected by diversion.
- Stream flow measurement data need to be from an unaltered reach (i.e., not at a bridge opening or similar).
- For inactive stream gages with 20+ years data the presence of a staff gage needs to be verified. Also there needs to be verification that there has not been a substantial shift in the stage-discharge curve due to changes in the channel cross-section. This should be done by comparing a current cross-section at the discharge measurement site to streamflow data. Changes in bankfull mean depth, width, or cross-sectional area up to 5% are acceptable.

- Annual Water Resources Data (WRD) reports and FEMA flood studies are government documents whose accuracy and completeness are verified before publication.

Stream gage data are used to verify the bankfull discharge and channel cross-sectional geometry at the stream gage site, reference reach, and study reach.

USGS 7.5 minute topographic maps are used for scale measurements and to identify site locations, land-use activities, and landscape features during an initial watershed survey.

For a continued discussion see Section B2, Task 1.

B10 – Data Management

All field data sheets to be used in field activities are included in Appendices A, B, D, G, and H. Field data sheets will be checked for completeness after each survey and at the end of each day. The field team captain will inspect field records before leaving the site. Field data sheets will be reviewed by the project manager each day. Any omissions or discrepancies will be handled immediately. Original field data sheets will remain in the possession of the field team member, and a copy will be placed in the project file along with any other pertinent site information. Refer to Section A9 for a more in-depth discussion on documentation and record keeping.

Any secondary data will be stored in the project file, in either hardcopy or electronic format.

All data will be entered into a computerized database/spreadsheet/computer aided design base program, designed for project needs. Computations will either be done by hand and computer drawings will be manually created, or values for survey cross-sections will be computer generated by the data values entered. All computer generated documents will be inspected for validity, completeness and accuracy by the quality control manager and project manager.

All project files and drawings will have a unique file name including the project number and name. Every drawing will have a back up copy.

Paper files will be maintained in a secure filing cabinet.

Electronic files are password protected and will not be modified without proper authorization. They shall be backed up every night and stored off-site. Inactive files are archived, and once archived they are changed to read-only status.

C1 – Assessments and Response Actions

The project manager will monitor and address all activities of the data collection process. Field assistants review field techniques as needed and have a review performed by the project manager annually. Data collection methods are standardized and the reporting method is consistent. The quality assurance manager will ensure that field team members are performing all data collection as prescribed by the quality assurance project plan.

All field activities may be reviewed and project sites may be visited by NHDES and EPA quality assurance officers as requested.

C2 – Reports to Management

The following documentation, as applicable to the project, will be presented at the end of data collection and analysis.

- Site sketch or plan showing limits of study and reference reaches, cross-section locations, profile alignment and other pertinent information.
- Cross-section plots
- Longitudinal profile plot
- Plan-view analysis
- Particle size distribution plots
- Bar/bulk sample results
- Calculations
- Results of bankfull calibration at stream gage including supporting documentation
- Stream classification summary
- Stream restoration plan

According to the scope of services listed in each grant agreement, semi-annual progress reports are submitted to DES on special forms each December 31 and June 30. A final project report is submitted when the project is finished.

D1 – Data Review, Verification and Validation

The project QA Officer will review all data collected as well as subsequent calculations to evaluate whether QC requirements have been met and whether data are usable to obtain the stated objectives of the project based on criteria contained in the QAPP. Subsequent final review and approval will be made by the Project Manager.

D2 – Verification and Validation Procedures

Field data are submitted to the Project Manager and QA Officer. The QA Officer reviews all field data for completeness. The Project manager makes sure that any questionable data are verified by speaking to the survey team or reviewing the field logbooks, and noting any unusual or anomalous data in the project files.

Any decisions made regarding the usability of data will be ultimately left to the Project Manager, however the Project Manager may consult with the QA Officer, project personnel, NHDES QA staff, or with personnel from EPA-NE.

When it is found that data do not meet the quality objectives from Section A7, or do not adhere to the quality control measures from Section B5, the Program Manager may determine what corrective action must be taken.

- Incomplete data may lead to the need for re-survey of the affected site if it is found that the available data are insufficient to meet project goals.
- When data quality is poor, the project manager will apply one of the following actions.
  1. Systems audit for measurements in question;
  2. Immediate on-site re-survey of the measurements in question;
  3. Rejection of data with a written explanation; or
  4. Rejection of the entire survey transect from the assessment with recommendation for relocation of survey site.

D3 – Reconciliation with User Requirements

Data will be generated based on the quality objectives defined in Section A-7 and verified according to Section D2. Limitations in the data will be clearly defined for potential end users in all reports produced

If the project objectives from Section A7 are met, the user requirements have been met. If the project objectives have not been met, corrective action as discussed in Section D2 will be established by the Project Manager.

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